MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

PPH 0135 – ELECTRICITY AND MAGNETISM
(Foundation in Engineering)

2 MARCH 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **FIVE** pages excluding the cover page and the appendices with **FIVE (5)** questions only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

QUESTION 1 (10 marks)

a) An electric dipole consists of two point charges, q_1 = 12 nC and q_2 = – 12 nC, placed 10 cm apart (**Figure Q1(a)**).

i) Compute the potentials at point A and B. [2 marks]

ii) If a charge, q_3 = 12 nC is placed at point B, find the magnitude and direction of the net force acting on it (q_3) [3 marks]

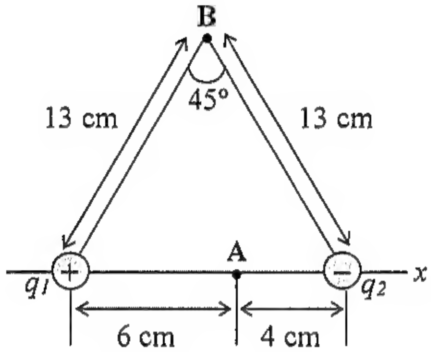


Figure Q1(a)

b) **Figure Q1(b)** shows a combination of capacitors in a circuit. Each capacitor has a capacitance of 2.0 μF.

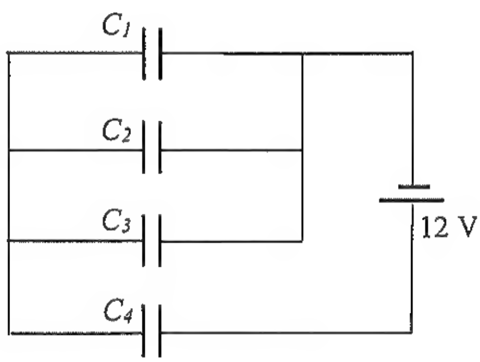


Figure Q1(b)

i) Determine the equivalent capacitance of the circuit. [1.5 marks]
ii) Calculate the amount of charge stored in C_3. [2 marks]
iii) Determine the voltage across C_2. [1.5 marks]

Continued ...

QUESTION 2 (10 marks)

a) A battery of $\xi = 2.50$ V has a terminal potential difference of 2.25 V when a resistor of 30.0 Ω is connected to it. Calculate the internal resistance, r, of the battery.
[2 marks]

b) A DC circuit, consists of two batteries is configured as shown in **Figure Q2(a)**.

i) Write the equation of Kirchhoff's current law applied at point **c**. [0.5 marks]

ii) Write the equation of Kirchhoff's voltage law for loop **abcda** and loop **cdefc**.
[2 marks]

iii) Based on parts (i) and (ii), determine $\mathbf{I_1}$ and $\mathbf{I_2}$. [2.5 marks]

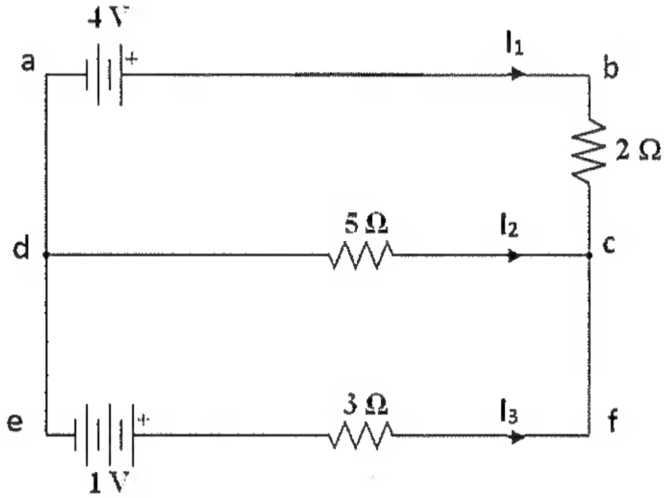
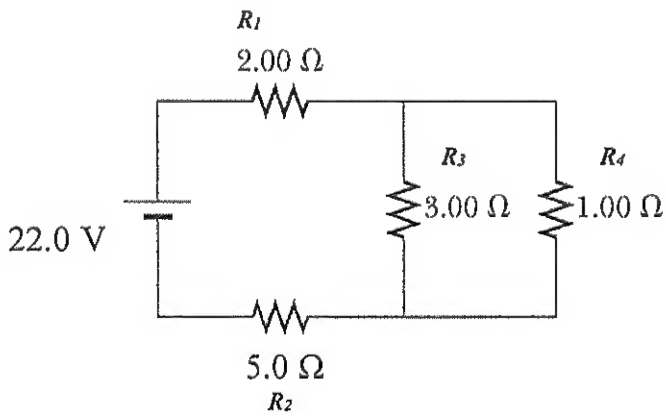


Figure Q2(a)

c) Find the equivalent Thevenin's resistance (R_{TH}) and the equivalent Thevenin's Voltage (V_{TH}) across resistor R_4 for the circuit shown in **Figure Q2(b)** below.



[3 marks]

Figure Q2(b)

Continued ...

QUESTION 3 (10 marks)

a) **Figure Q3(a)** shows a copper wire carrying a current of I in free space. Redraw **Figure Q3(a)** and sketch the magnetic field produced by the copper wire. [1 mark]

Figure Q3(a)

b) Two wires, X and Y, are carrying currents of 4A and 6A, respectively, as shown in **Figure Q3(b).**

i) Draw the directions of the magnetic field at point P. [1 mark]

ii) Calculate the magnitude of the magnetic field at point **P** due to the currents in wire X and wire Y. [2 marks]

iii) Determine the net magnitude and direction of the magnetic field at point P. [3 marks]

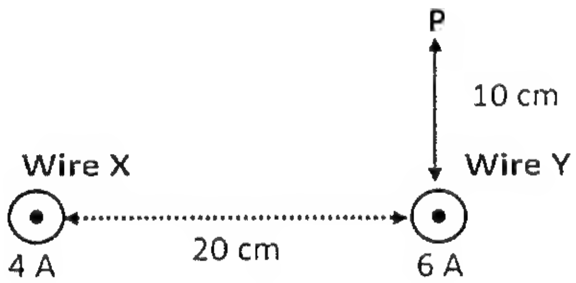


Figure Q3(b)

c) Two solenoids A and B, which are placed close to each other, have 300 and 600 turns, respectively. A current of 1.5A flows through coil A, produces magnetic flux of 1.2×10^{-4} Weber through each turn of A and a flux of 0.9×10^{-4} Weber through each turn of B.

i) Determine mutual inductance of A and B. [1.5 marks]

ii) Find the average e.m.f. induced in coil B when the current in coil A is stopped in 0.2s. [1.5 marks]

Continued ...

QUESTION 4 (10 marks)

a) In a certain series RLC circuit operating at the frequency of 40.0 Hz, the rms current is 4.0A, the rms voltage is 240V, and the current leads the voltage by 50°.

i) Find the impedance, Z of the RLC network, hence determine the resistance, R of the circuit at 40 Hz. [2 marks]

ii) Calculate the **reactive** power and the **apparent** power of the circuit at 40 Hz. [2 marks]

b) A series *RLC* circuit containing a 50 Hz power source with $V_{rms} = 300$ V, a resistor, $R = 200\ \Omega$, an inductor, $L = 500$ mH, and a capacitor, $C = 10\ \mu$F.

i) Determine the value of the peak voltage of the source. [1 mark]

ii) Calculate the impedance of the circuit. [3 marks]

iii) If the frequency of the power source is changed to resonance frequency of the circuit, find maximum current flowing in the circuit. [1 mark]

iv) Determine the resonance frequency of the circuit. [1 mark]

Continued ...

QUESTION 5 (10 marks)

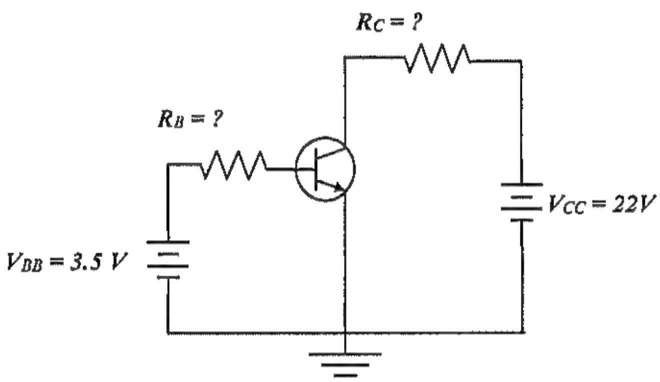
a) What is meant by doping in semiconductors? [1 mark]

b) There are two types of Bipolar Junction Transistor (BJT).

i) Name the two types of BJT. [1 mark]

ii) Draw the electronic symbol of each transistor in part (i). Label all terminals in each symbol. [2 marks]

c) **Figure Q5** shows a germanium transistor circuit with two unknown resistors, the base terminal resistor R_B and the collector terminal resistor R_C. If the collector current, $I_C = 7.0$ mA , $\alpha_{dc} = 0.6$, $\beta_{dc} = 42$, and $V_{CE} = 8.5$ V, find the values of R_B and R_C.



[6 marks]

Figure Q5

End of Paper

APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^{8} m/s
Rydberg constant	R_H	1.097×10^{7} m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^{9} N m^2/C^2
Permittivity of free space	ε_0/κ_0	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$
$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$
$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$
$$B = \frac{\mu_0 I}{2\pi r}$$
$$B = \mu_0 nI$$
$$\xi = V + Ir$$
$$\xi = blv$$
$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$
$$\xi = -L\frac{dI}{dt}$$
$$\xi = -M\frac{dI}{dt}$$
$$F = BIL\sin\theta$$
$$F = qvB\sin\theta$$
$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$
$$f_r = \frac{1}{2\pi\sqrt{LC}}$$
$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$
$$I = neA(v_n + v_p)$$
$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$
$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$
$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$
$$L = \frac{N\Phi_B}{I}$$
$$L = \frac{\mu_o N^2 A}{l}$$
$$M = \frac{N\Phi_B}{I}$$
$$M = \frac{\mu_o N_1 N_2 A}{l}$$
$$P = IV = I^2 R = \frac{V^2}{R}$$
$$P_t = I_{rms}V_{rms}\cos\phi$$
$$P_r = V_{rms}I_{rms}\sin\phi$$
$$P_a = I_{rms}^2 Z$$
$$R = \frac{\rho L}{A}$$
$$R = R_0[1+\alpha(T-T_0)]$$
$$R_T = R_1 + R_2 + R_3 + \ldots$$
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$
$$\tau = NBIA\sin\theta$$
$$U = \frac{1}{2}LI^2$$
$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$
$$V_H = Bvd$$
$$V = V_{max}\sin\omega t$$
$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$
$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$
$$X_C = \frac{1}{2\pi fC}$$
$$X_L = 2\pi f L$$
$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$
$$\oint B.dl = \mu_o I$$
$$d\mathbf{B} = \frac{\mu_0 I}{4\pi}\frac{d\ell \times \hat{\mathbf{r}}}{r^2}$$
$$\Phi_B = BA\cos\theta$$
$$\cos\phi = \frac{R}{Z}$$
$$\tan\phi = \frac{X_L - X_C}{R}$$